2.0 HYDROGEOLOGIC INVESTIGATION

2.1 PURPOSE AND SCOPE

A hydrogeologic investigation was conducted at the site to better define the groundwater flow pathway characteristics for contaminant migration in the aquifer underlying the site. To aid in the hydrogeologic investigation discussed below and the groundwater sampling investigation discussed in Section 7.0, a total of 24 new monitor wells (see **Table 2-1**) were installed at the approximate locations shown in **Figure 2-1**. The data collected from the installation and testing of these new monitor wells during this RI was used to supplement the data collected from all the existing monitor wells listed in Tables 1-2 and 1-6, as well as the data collected from the 9 monitor wells installed by Mead Corporation during their "Post-Removal Baseline Assessment" of the coke plant (see **Table 2-2**). The locations of the Mead monitor wells are also shown in Figure 2-1. During this RI, the following testing and measurement activities were performed:

- Lithostratigraphic logging of the deepest boreholes drilled at each monitor well cluster location

- In situ hydraulic conductivity testing of the aquifer at 23 of the 24 new monitor well locations

- Collection of groundwater level measurements (in June 1996) from the 24 newly installed monitor wells (see Table 2-1), the 8 monitor wells installed by the state at the coke plant (see Table 1-3), the 9 monitor wells installed by Mead Corporation at the coke plant (see Table 2-2), 2 monitor wells (MC-01 and MC-03) installed by the state at the Morningside Chemical Company Site (see Table 1-7), 2 monitor wells (LC-02 and LC-05) installed by the state at the Landes Company Site (see Table 1-7), and the 27 monitor wells installed by Velsicol Chemical Corporation on their property (see Table 1-7)

- Collection of surface water level measurements (in June 1996) at three staff gage (SG) locations in Chattanooga Creek

TABLE 2-1

NEW MONITOR WELL CONSTRUCTION DETAILS
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

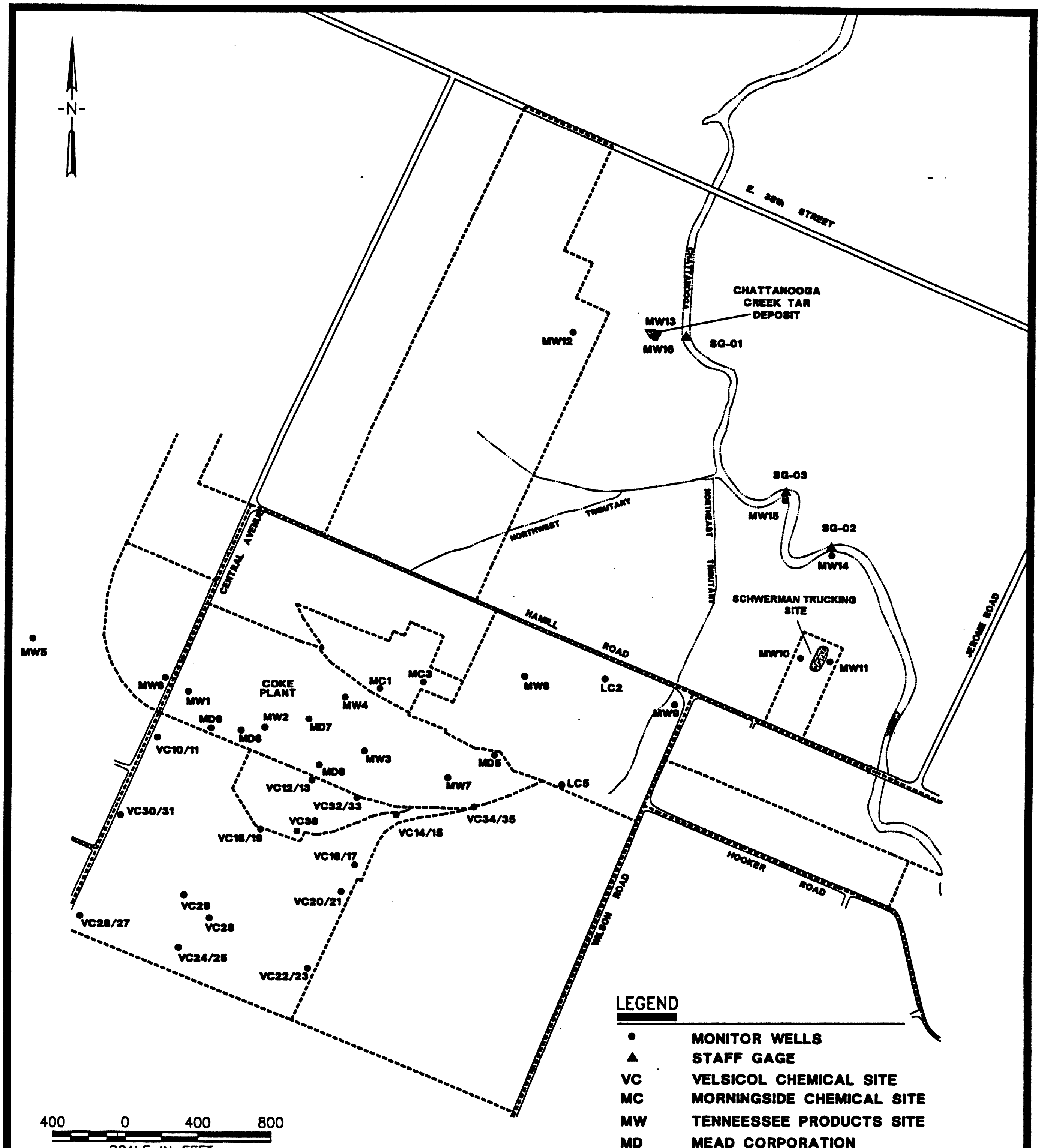
Well Number	Total Depth (feet)	Well Diameter (inches)	Depth of Screened Interval (feet)		Elevation (feet msl)	
			From	To	TOC	Ground
MW-01-IN	54	2	43	53	680.93	676.6
MW-02-IN	35	2	24	34	677.97	674.9
MW-03-IN	41	2	30	40	676.22	673.4
MW-04-IN	47	2	36	46	674.66	671.7
MW-05-SH	38	2	27	37	729.94	730.0
MW-05-IN	53	2	41	51	729.29	729.4
MW-06-SH	14	2	3.5	13.5	677.84	678.1
MW-06-IN	54.6	2	44.3	54.3	678.43	678.4
MW-07-SH	13	2	2.5	12.5	667.32	664.4
MW-07-IN	29	2	18.5	28.5	666.79	664.9
MW-08-SH	12.5	2	2	12	656.56	654.1
MW-08-IN	27.8	2	17.5	27.5	656.67	654.1
MW-09-SH	18	2	7	17	659.03	656.1
MW-09-IN	31.5	2	21	31	659.20	656.3
MW-10-SH	25	2	7	17	651.10	651.2
MW-10-IN	34.8	2	24.5	34.5	650.90	651.0
MW-11-SH	12	2	1.5	11.5	654.34	651.7
MW-11-IN	34	2	23.5	33.5	654.24	651.6

TABLE 2-1 (Cont.)

NEW MONITOR WELL CONSTRUCTION DETAILS
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Well Number	Total Depth (feet)	Well Diameter (inches)	Depth of Screened Interval (feet)		Elevation (feet msl)	
			From	To	TOC	Ground
MW-12-SH	14	2	3	13	655.90	652.9
MW-12-IN	38	2	27	37	655.65	652.5
MW-13-SH	10.8	2	0.8	10.8	644.81	641.7
MW-14-SH	15	2	3	13	645.80	643.6
MW-15-SH	14	2	3.5	13.5	645.37	643.7
MW-16-SH	10.3	2	0.3	10.3	644.66	641.8

Notes: TOC - Top of Casing
Depths are measured from land surface



LEGEND

●	MONITOR WELLS
▲	STAFF GAGE
VC	VELSICOL CHEMICAL SITE
MC	MORNINGSIDE CHEMICAL SITE
MW	TENNEESSEE PRODUCTS SITE
MD	MEAD CORPORATION
LC	LANDES COMPANY SITE

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RI HYDROGEOLOGIC TESTING AND MEASUREMENT LOCATIONS

Tennessee Products Site
Chattanooga, Tennessee

CDM FEDERAL PROGRAMS CORPORATION
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FIGURE No. 2-1

TABLE 2-2

MEAD CORPORATION MONITOR WELL CONSTRUCTION DETAILS
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Well Number	Total Depth (feet)	Well Diameter (inches)	Depth of Screened Interval (feet)		Elevation (feet msl)	
			From	To	TOC	Ground
MD-05-12	12	2	2	12	660.72	658.8
MD-05-20	20.5	2	15.5	20.5	661.02	659.4
MD-05-102	102	2	92	102	660.94	658.7
MD-06-14	14	2	4	14	673.93	671.9
MD-06-73	73	2	63	73	673.71	671.9
MD-07-12	12.5	2	2.5	12.5	674.91	673.1
MD-07-51	51	2	41	51	674.84	673.0
MD-08-63	63	2	53	63	677.63	NA
MD-09-20	20	2	10	20	683.35	680.4

Notes: TOC - Top of Casing
NA - Not Available
Depths are measured from land surface

- Collection of streamflow measurements (in June 1996) at three locations in Chattanooga Creek

The locations of all the wells and surface water points where hydrogeologic testing and measurement activities were conducted as part of this RI are shown in Figure 2-1. The results of the testing and measurement activities are discussed in the sections below.

2.2 MONITOR WELL INSTALLATION

Monitor well installation consisted of overseeing the drilling, installation, and development of 24 permanent monitor wells. Split spoon soil samples and bedrock core samples were collected and logged during drilling of the wells at each monitor well cluster to identify the lithologic variability across the site. All well and soil boring logs are provided in **Appendix A**.

The procedures for drilling, installing, and developing the wells, and decontaminating the equipment are described in detail in the *Final Work Plan* (CDM Federal, 1995) for the Tennessee Products Site RI/FS. The drilling and construction of all wells were performed under the continuous supervision of an experienced geologist. All wells were installed in a manner that minimized the chance of cross-contamination. All wells were surveyed and located horizontally and vertically in reference to the site datum using state planar coordinates.

Well construction diagrams for all the new monitor wells are presented in **Appendix B**, and some of the more pertinent well construction details are listed in Table 2-1. All shallow wells were completed in the soil overburden or fill material and screened across the water table. Generally, shallow wells were drilled and installed through hollow stem augers. The only exception is monitor well MW-10-SH which was drilled using air rotary techniques in order to drill through hard fill material. Intermediate wells were screened in the highly-weathered and/or fractured uppermost zone of the bedrock, and were drilled with air rotary techniques. At locations where there is a suitable thickness of relatively competent rock above the first fracture zone, a 6-inch carbon steel surface casing was set into the more competent rock and pressure grouted into place. The casing was allowed to set for a minimum of 24 hours prior to continuing drilling.

All well screens and riser pipes are 2 inches in diameter and are constructed of stainless steel. A sand filter pack was placed around each well screen, extending a minimum of 2 feet above the top of the well screen in the monitor wells. A seal of pure bentonite slurry or bentonite pellets was also placed on top of the sand pack and extended to within 2 feet of land surface. After a minimum of 24 hours, the remaining annular space was filled with concrete, and a protective casing with locking cap was installed over each monitor well and encased in a concrete pad. The monitor wells were completed either as standup wells with four bumper posts installed around each well head, or flush mount wells with the concrete pads constructed level with the ground surface.

After each monitor well was completed, it was developed until the development water was free of visible sediment, and the pH, temperature, conductivity, and turbidity of the development water were stabilized. All the monitor wells were developed by overpumping.

As part of the "Post-Removal Baseline Assessment" of the coke plant conducted by Mead Corporation in 1995, nine monitor wells were installed at the coke plant. Since these monitor wells were used to collect both water level measurements and groundwater samples during this RI, the pertinent well construction details for these monitor wells are provided in Table 2-2. Details on how these wells were constructed are provided in the *Post-Removal Baseline Assessment Report* (Mead, 1995).

2.3 SITE-SPECIFIC GEOLOGY

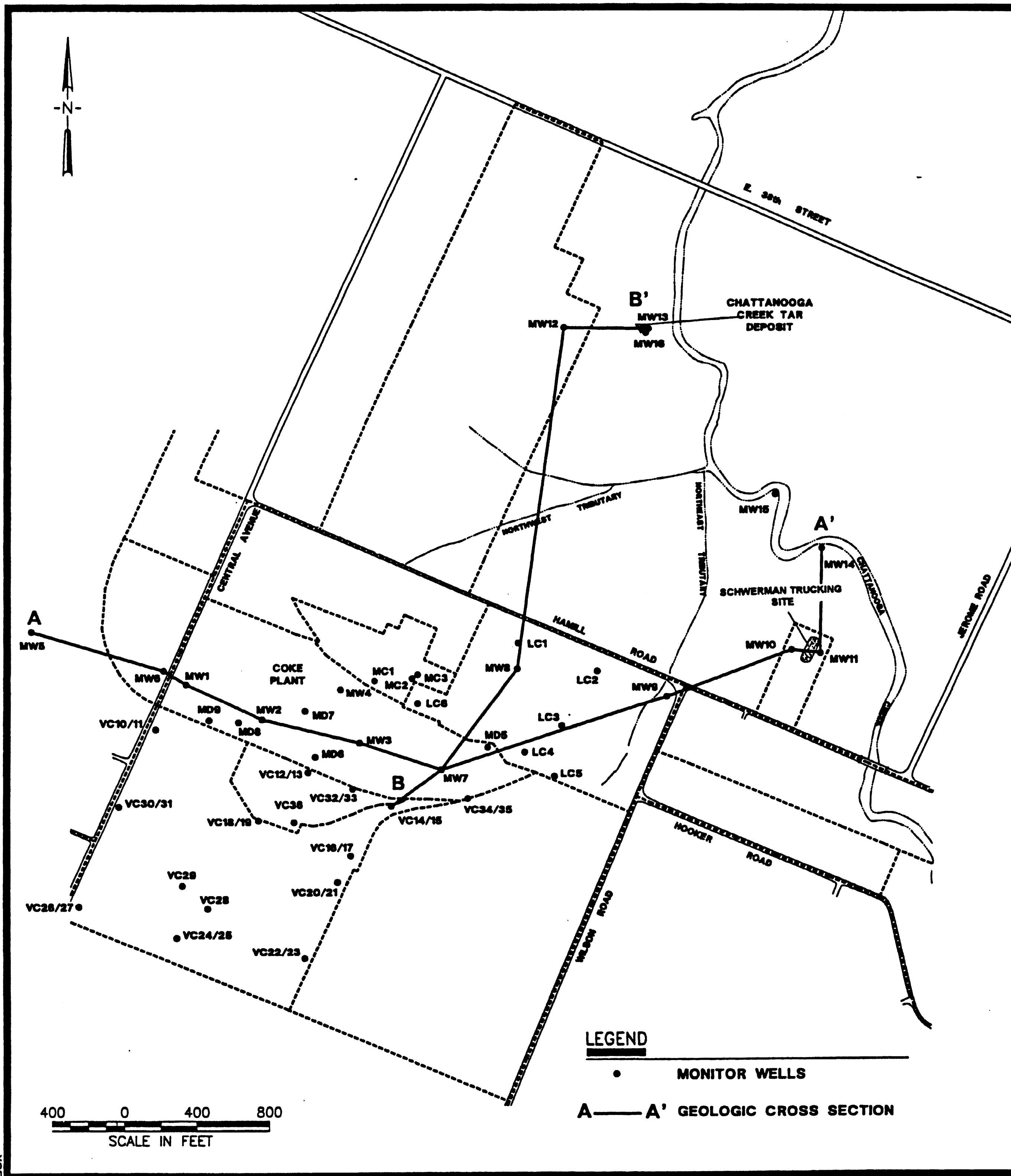
The coke plant is located on the east limb of the Lookout Mountain syncline and west of the Chattanooga fault (see Figure 1-10). Rocks in this area are of the Chickamauga Supergroup. The data collected from the borings completed during this investigation, as well as those from previous studies (Westinghouse, 1990, and ERM, 1995), were used to construct the cross sections shown on **Figure 2-2**. Cross Section A-A' (**Figure 2-3**) is an approximately east-west section from the background area (MW-05-IN) through the coke plant and ST Site to Chattanooga Creek. Cross Section B-B' (**Figure 2-4**) is a north-south section across the coke plant to the Chattanooga Creek floodplain tar deposit.

Bedrock throughout the study area consists of light, medium and dark gray and blue-gray, crystalline limestone. The limestone is generally massive to nodular in a limey mudstone matrix, and occasionally bedded. Shale was encountered in bedrock throughout the site in layers generally less than a foot thick. Approximately 8 feet of maroon limey mudstone was encountered in MW-08-IN. Chert and calcite-replaced fossils are a minor constituents.

Fractures in the bedrock are generally horizontal to low angle, and occur as open fractures as well as mud and calcite filled. Significant solution voids, generally partially to completely mud-filled, were encountered in the following coreholes: MW-06-IN, MW-01-IN, MW-10-IN and MW-12-IN.

The bedrock is overlain by unconsolidated materials. Throughout the majority of the site these materials consist of clay residuum formed from the weathering of the underlying limestone. In the coke plant and ST Site areas, the residuum is overlain by fill. In the floodplain of Chattanooga Creek, including the ST Site area, the overburden includes a significant layer (up to eight feet thick) of well sorted, angular, chert sand and gravel or sandy clay. This layer is immediately overlying the bedrock or very close to bedrock. In these areas the sand and gravel layer is overlain by clay.

The top of bedrock is an irregular erosional feature which, as shown on geologic cross sections A-A' and B-B', generally slopes to the north and east. Data from borings conducted in this and previous investigations indicate that the surface may be pinnacled, with steep changes in the elevation of the top of bedrock occurring over relatively short distances (e.g., 662 feet



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LOCATIONS OF GEOLOGIC CROSS SECTIONS

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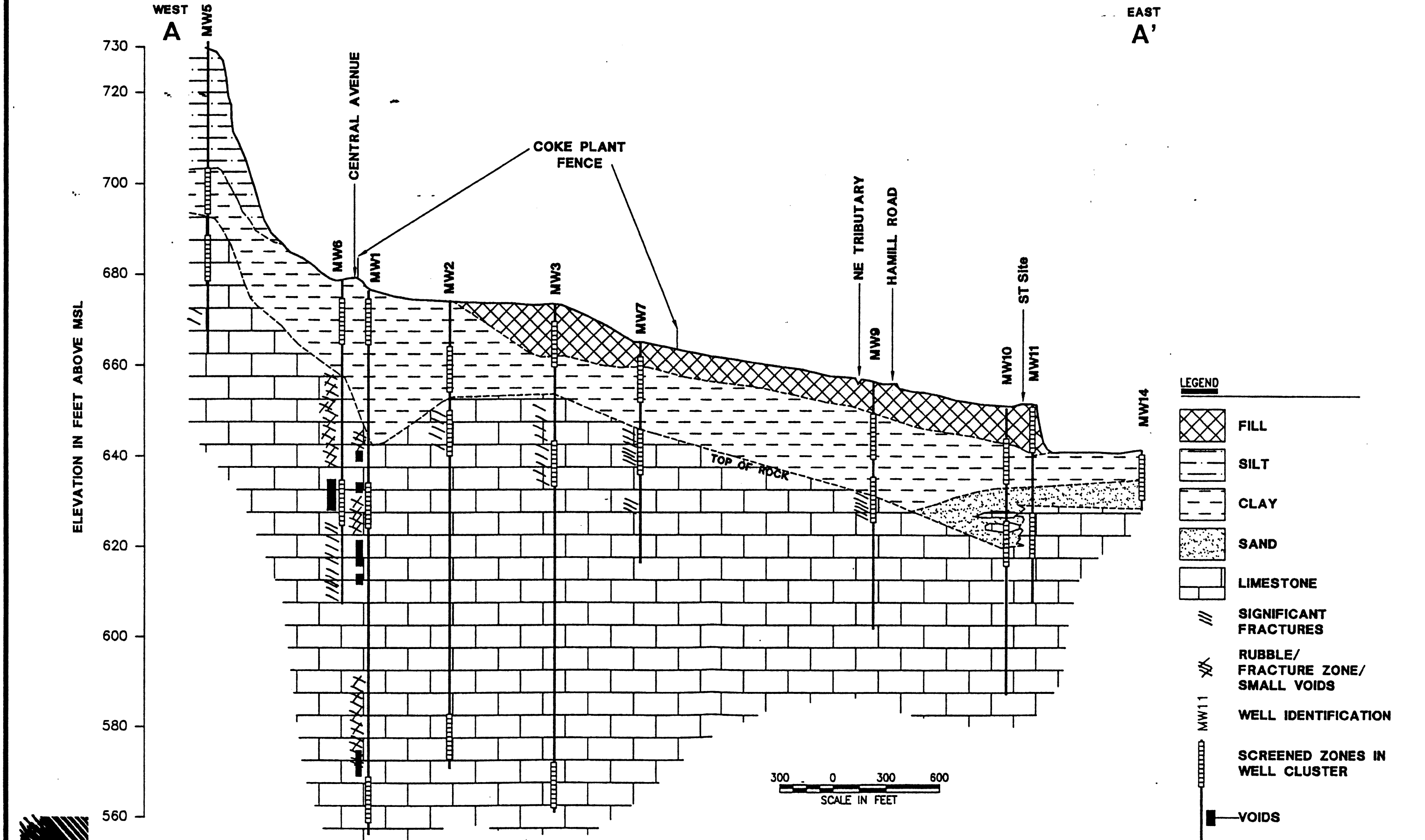
Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 2-2



CDM FEDERAL PROGRAMS CORPORATION
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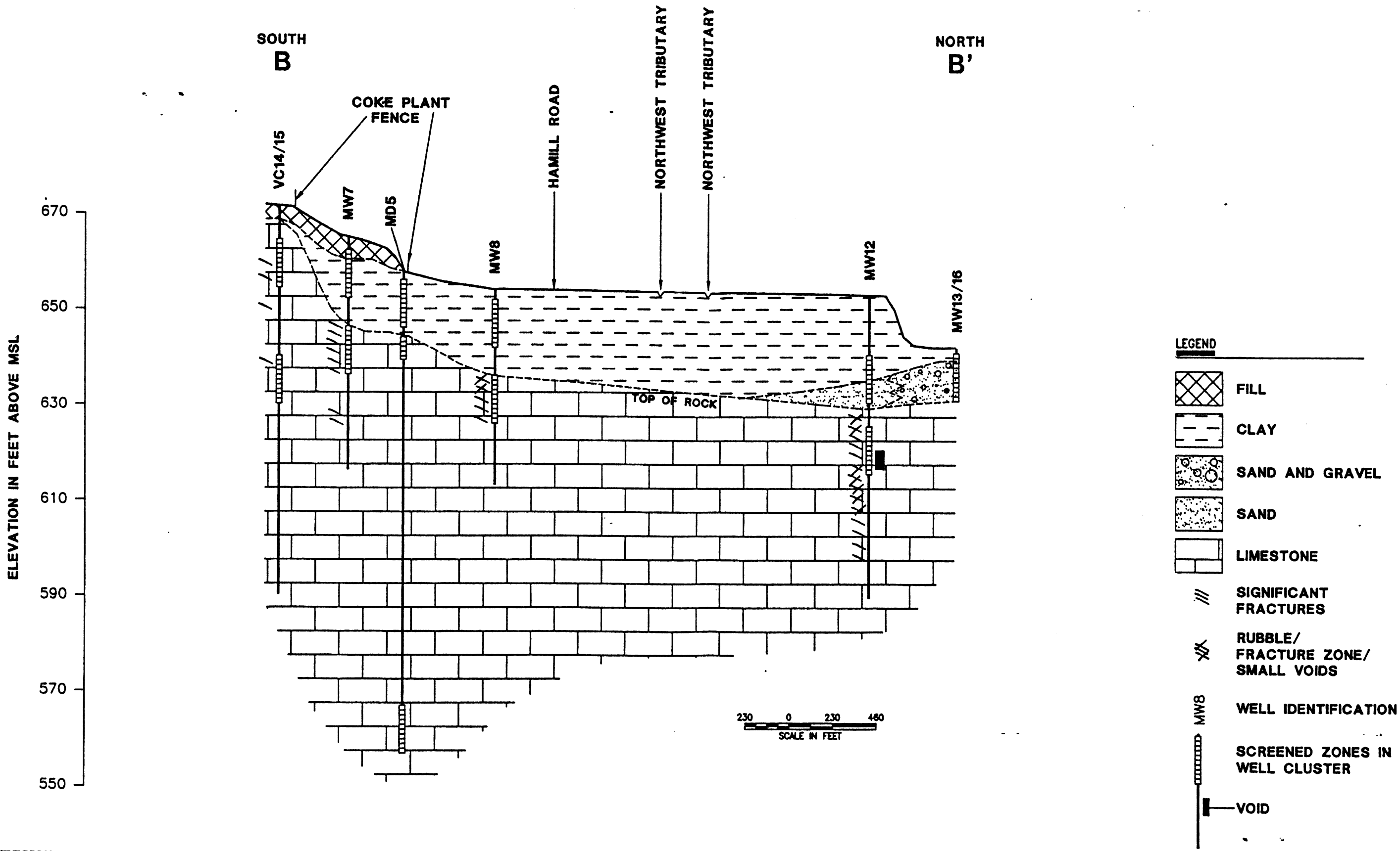
GEOLOGIC CROSS SECTION A-A'
Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 2-3



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GEOLOGIC CROSS SECTION B-B'
Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 2-4

above msl at MW-04-SH and 647 feet above msl at MW-04-IN located approximately 50 feet to the south).

2.4 SITE-SPECIFIC HYDROGEOLOGY

Groundwater at the Tennessee Products Site generally occurs in two hydrostratigraphic zones. The uppermost zone consists of unconsolidated soil and saprolite material. In this report, this hydrostratigraphic zone is referred to as the soil overburden zone within the upland portion of the site and the floodplain sediments within the Chattanooga Creek floodplain portion of the site. Water in this hydrostratigraphic zone generally moves through pore spaces of the unconsolidated material as well as relict fractures within the saprolite. The second hydrostratigraphic zone of groundwater occurrence is the bedrock zone where groundwater moves through fractures and secondary openings. The upper part of the bedrock zone is fairly well fractured. However, in general, the size and frequency of fractures decrease markedly with increasing depth. Although the characteristics of the soil overburden/floodplain sediments and the bedrock hydrostratigraphic zones are very different, they actually act as one aquifer since the two zones are hydraulically connected, as evidenced by the lack of both a confining zone and significant head difference between the two hydrostratigraphic zones.

2.4.1 HORIZONTAL GROUNDWATER FLOW

To add to the horizontal hydraulic conductivity database for the aquifer at the site, in situ hydraulic conductivity tests (slug tests) were conducted in all the newly installed monitor wells except for MW-03-IN. A slug test was not performed at this location since data from well development indicated the well would not recover within 24 hours (recovery after pumping was very slow). Detailed descriptions of the tests conducted and the data collected during this RI, and the method of analysis are presented in **Appendix C**. The results of all the tests conducted at or near the site prior to and during this RI are presented in **Tables 2-3** through **2-6**. As indicated in these tables, the slug testing result ranges and averages of horizontal

TABLE 2-3

IN SITU HYDRAULIC CONDUCTIVITY TEST RESULTS - SOIL OVERBURDEN TENNESSEE PRODUCTS SITE CHATTANOOGA, TENNESSEE

Well ID		Hydraulic Conductivity (feet/day)
MW-01-SH		0.30[a]
MW-02-SH		3.94[a]
MW-03-SH		1.42[a]
MW-05-SH		4.23
MW-06-SH		49.8
MW-07-SH		18.4
MW-08-SH		53.0
MW-09-SH		14.7
MW-10-SH		2.62
MW-11-SH		1.54
MW-12-SH		92.1
MD-05-12		1.30[a]
MD-06-14		1.04[a]
MD-07-12		0.09[a]
MD-09-20		0.08[a]
	Geometric Mean[b]	3.05

[a] Results for rising head test as reported in *Post-Removal Baseline Assessment Report*, for the Chattanooga Coke Plant (Mead, 1995).

[b] Geometric Mean = $^{n}\ k_1 k_2 k_3 ... k_n$

TABLE 2-4

IN SITU HYDRAULIC CONDUCTIVITY TEST RESULTS -
FLOODPLAIN SEDIMENTS
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Well ID		Hydraulic Conductivity (feet/day)
MW-13-SH		49.0
MW-14-SH		32.6
MW-15-SH		361.
MW-16-SH		195.
	Geometric Mean[b]	103

[b] Geometric Mean = $^{n}\ k_1k_2k_3...k_n$

TABLE 2-5

IN SITU HYDRAULIC CONDUCTIVITY TEST RESULTS -
UPPER BEDROCK
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Well ID		Hydraulic Conductivity (feet/day)
MW-01-IN		5.45
MW-02-IN		0.80
MW-04-IN		3.01
MW-05-IN		0.38
MW-06-IN		0.15
MW-07-IN		1.12
MW-08-IN		4.06
MW-09-IN		0.02
MW-10-IN		33.0
MW-11-IN		1.42
MW-12-IN		2.15
MD-05-20		0.08[a]
MD-06-73		3.49[a]
MD-07-51		0.13[a]
MD-08-63		0.03[a]
	Geometric Mean[b]	0.72

[a] Results for rising head test as reported in *Post-Removal Baseline Assessment Report*, for the Chattanooga Coke Plant (Mead, 1995).

[b] Geometric Mean = $\sqrt[n]{k_1 k_2 k_3 \ldots k_n}$

TABLE 2-6

IN SITU HYDRAULIC CONDUCTIVITY TEST RESULTS -
LOWER BEDROCK
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Well ID		Hydraulic Conductivity (feet/day)
MW-01-DP		4.49[a]
MW-02-DP		0.21[a]
MW-03-DP		0.06[a]
MW-04-DP		0.04[a]
MD-05-102		0.27[a]
	Geometric Mean[b]	0.23

[a] Results for rising head test as reported in *Post-Removal Baseline Assessment Report*, for the Chattanooga Coke Plant (Mead, 1995).

[b] Geometric Mean = $\sqrt[n]{k_1 k_2 k_3 \ldots k_n}$

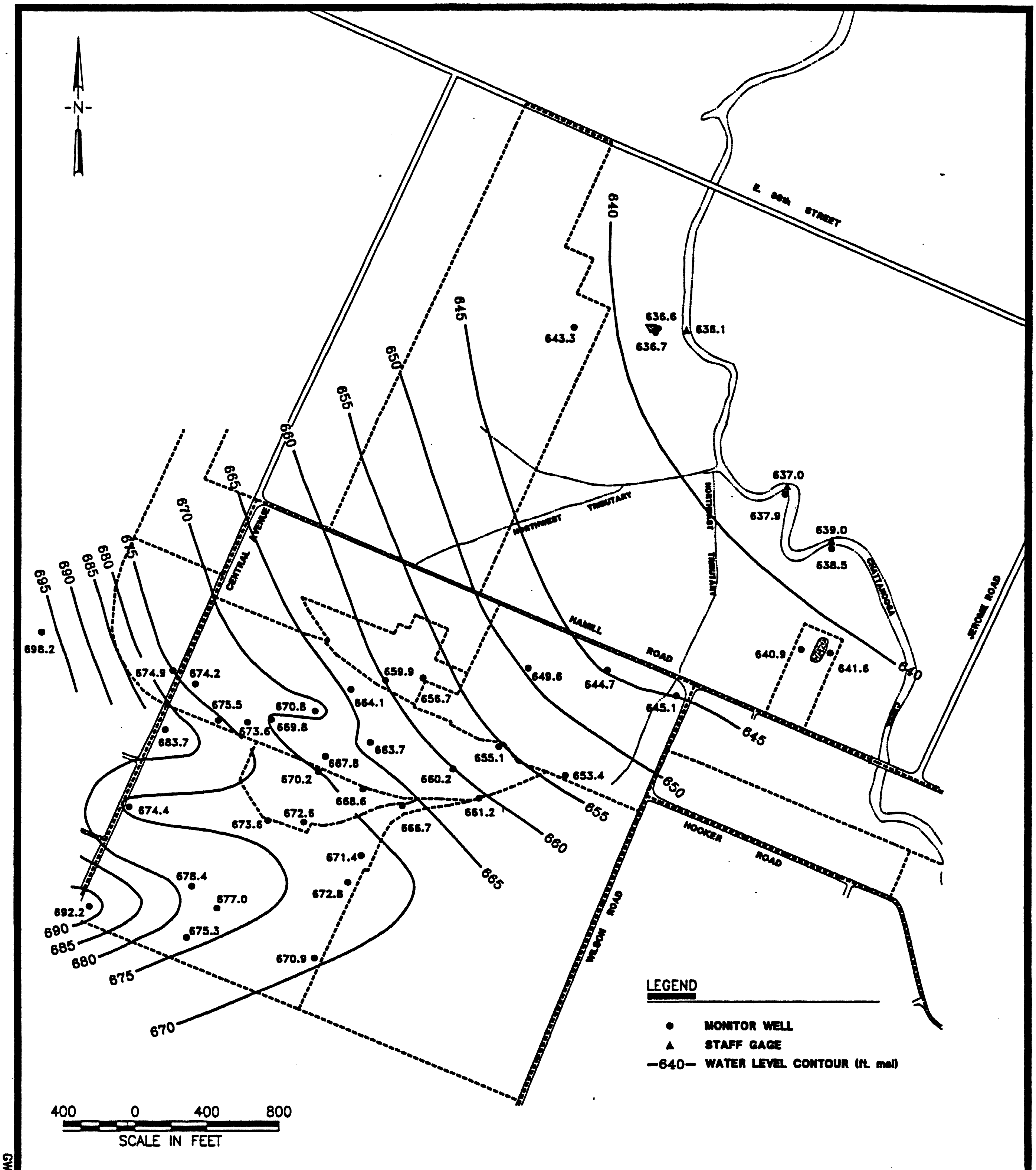
hydraulic conductivities for the four different types of sediment and bedrock zones monitored at the site are as follows:

Sediment/Bedrock Zone	In Situ Hydraulic Conductivity Range	Test Results (ft/day) Average
Soil Overburden	0.08 to 92.1	3.05
Floodplain Sediments	32.6 to 361	103
Upper Bedrock	0.03 to 33.0	0.72
Lower Bedrock	0.04 to 4.49	0.23

Note that the average hydraulic conductivities were calculated using a geometric mean, as recommended by Schilfgaarde (1974). The large ranges (up to 3 orders of magnitude) of hydraulic conductivity indicate a high degree of variability, even within each sediment/bedrock zone. This high degree of variability is most likely reflective of the varying types of sediments and bedrock intervals composing the aquifer (i.e., silts, sands, clays, highly fractured bedrock intervals, and poorly fractured bedrock intervals). Because of this high degree of variability, the aquifer at the Tennessee Products Site is best described as being very heterogeneous where groundwater flow rates are highly variable, and contaminants, in general, will follow preferential pathways within and between the hydrostratigraphic zones.

A potentiometric surface map of the aquifer system at the site is presented in **Figure 2-5**. This map is based on the water level measurements presented in **Table 2-7**, which were collected in June 1996. This potentiometric surface map was produced by averaging the upper bedrock and soil overburden (or floodplain sediment) water level measurements at each well cluster presented in Table 2-7, when more than one well exists at the location.

Figure 2-5 shows that the horizontal direction of groundwater flow at the site is generally northeast (toward Chattanooga Creek) with an average hydraulic gradient of approximately 0.014 feet/feet across the coke plant area and 0.005 feet/feet in the Chattanooga Creek floodplain. Groundwater and surface water data collected in June 1996 also indicate that for



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GROUNDWATER LEVELS - JUNE 1996

CDM FEDERAL PROGRAMS CORPORATION
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Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 2-5

TABLE 2-7

WATER LEVEL MEASUREMENTS - JUNE 1996
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Location ID	TOC Elevation (feet msl)	Water Depth (feet)	Water Elevation (feet msl)
MW-01-SH	679.00	6.09	672.91
MW-01-IN	680.93	5.52	675.41
MW-01-DP	678.77	3.50	675.27
MW-02-SH	678.15	8.15	670.00
MW-02-IN	677.97	8.37	669.60
MW-02-DP	677.62	6.99	670.63
MW-03-SH	676.41	12.59	663.82
MW-03-IN	676.22	12.66	663.56
MW-03-DP	676.55	14.31	662.24
MW-04-SH	673.37	9.01	664.36
MW-04-IN	674.66	10.81	663.85
MW-04-DP	673.04	10.86	662.18
MW-05-SH	729.94	29.71	700.23
MW-05-IN	729.29	33.06	696.23
MW-06-SH	677.84	4.86	672.98
MW-06-IN	678.43	1.63	676.80
MW-07-SH	667.32	7.10	660.22
MW-07-IN	666.79	6.54	660.25
MW-08-SH	656.56	7.01	649.55
MW-08-IN	656.67	7.07	649.60
MW-09-SH	659.03	13.65	645.38
MW-09-IN	659.20	14.34	644.86

TABLE 2-7 (Cont.)

WATER LEVEL MEASUREMENTS - JUNE 1996
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Location ID	TOC Elevation (feet msl)	Water Depth (feet)	Water Elevation (feet msl)
MW-10-SH	651.10	9.90	641.20
MW-10-IN	650.90	10.32	640.58
MW-11-SH	654.34	12.25	642.09
MW-11-IN	654.24	13.14	641.10
MW-12-SH	655.90	11.54	644.36
MW-12-IN	655.65	13.48	642.17
MW-13-SH	644.81	8.22	636.59
MW-14-SH	645.80	7.31	638.49
MW-15-SH	645.37	7.44	637.93
MW-16-SH	644.66	7.98	636.68
MD-05-12	660.72	6.30	654.42
MD-05-20	661.02	5.24	655.78
MD-05-102	660.94	ND	---
MD-06-14	673.93	6.89	667.04
MD-06-73	673.71	5.15	668.56
MD-07-12	674.91	3.85	671.06
MD-07-51	674.84	4.29	670.55
MD-08-63	677.63	4.08	673.55
MD-09-20	683.35	7.85	675.50

TABLE 2-7 (Cont.)

WATER LEVEL MEASUREMENTS - JUNE 1996
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Location ID	TOC Elevation (feet msl)	Water Depth (feet)	Water Elevation (feet msl)
MC-01	665.47	5.60	659.87
MC-03	661.80	5.08	656.72
LC-02	655.97	11.29	644.68
LC-05	662.04	8.68	653.36
VC-10	692.11	7.81	684.30
VC-11	692.33	9.16	683.17
VC-12	678.04	7.19	670.85
VC-13	678.34	8.69	669.65
VC-14	674.29	7.91	666.38
VC-15	674.51	7.48	667.03
VC-16	680.98	9.60	671.38
VC-17	682.1	DRY	---
VC-18	682.44	DRY	---
VC-19	682.20	8.55	673.65
VC-20	680.85	8.09	672.76
VC-21	680.72	7.91	672.81
VC-22	681.17	9.91	671.26
VC-23	681.18	10.66	670.52
VC-24	692.66	17.85	674.81
VC-25	692.83	17.13	675.70

TABLE 2-7 (Cont.)

WATER LEVEL MEASUREMENTS - JUNE 1996
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Location ID	TOC Elevation (feet msl)	Water Depth (feet)	Water Elevation (feet msl)
VC-26	703.42	9.71	693.71
VC-27	703.34	12.72	690.62
VC-28	687.91	10.88	677.03
VC-29	688.40	9.99	678.41
VC-30	699.15	25.07	674.08
VC-31	699.36	24.73	674.63
VC-32	677.56	8.72	668.84
VC-33	677.50	9.12	668.38
VC-34	666.14	5.00	661.14
VC-35	665.64	4.30	661.34
VC-36	676.47	3.92	672.55
SG-01	641.06	4.94	636.12
SG-02	643.66	4.66	639.00
SG-03	641.45	4.45	637.00

Notes: TOC - Top of Casing/Pipe
ND - No Data (Well had not fully recovered from sampling)
Depths measured from TOC/Pipe

the most part, during dry periods (i.e., no significant rainfall runoff into Chattanooga Creek), groundwater discharges to Chattanooga Creek. However, during wet periods, a temporary flow reversal is expected to occur along Chattanooga Creek where the surface water recharges groundwater.

Note that although the general direction of groundwater flow is toward Chattanooga Creek, the actual direction of groundwater flow, especially in the bedrock hydrostratigraphic zone, at any given location at the site may vary substantially from the general area-wide direction of flow. Groundwater flow in bedrock aquifers, in general, is controlled by the geometry, orientation, and interconnections within the bedrock fractures. Because these properties are usually quite variable in bedrock, local flow fields at the site are likely very complex. Hence, while groundwater at the site will eventually discharge into Chattanooga Creek, the path it takes to get there may be very tortuous.

As indicated above, groundwater flow rates at the site are highly variable due to the heterogenous nature of the aquifer. Nevertheless, average horizontal groundwater flow velocities were calculated for the four sediment/bedrock zones monitored, and are presented in **Table 2-8** to indicate the potential general rates of groundwater movement across the site. The average horizontal groundwater flow velocities were calculated (based on Darcy's Law for groundwater flow) using the average hydraulic conductivities and hydraulic gradients presented above, and typical effective porosities reported in literature for similar types of lithology. The results of these calculations indicate that groundwater, in general, moves moderately fast at the site, and hence could have facilitated extensive migration of contaminants from the coke plant, given the 78 year history of coke plant operations.

2.4.2 VERTICAL GROUNDWATER FLOW

As indicated in Table 2-7, the vertical direction of groundwater flow at the site appears to vary randomly from location to location. At 14 monitor well clusters, water levels were higher in

TABLE 2-8

AVERAGE GROUNDWATER FLOW VELOCITIES
TENNESSEE PRODUCTS SITE
CHATTANOOGA, TENNESSEE

Area	Aquifer Zone	Average Hydraulic Conductivity (ft/day)	Average Hydraulic Gradient (ft/ft)	Typical Effective Porosity*	Calculated Groundwater Velocity (ft/year)
Coke Plant	Soil Overburden	3.05	0.014	0.20	78
	Upper Bedrock	0.72	0.014	0.10	38
	Lower Bedrock	0.23	0.014	0.10	12
Floodplain	Floodplain Sediments	103	0.005	0.25	752
	Upper Bedrock	0.72	0.005	0.10	13
	Lower Bedrock	0.23	0.005	0.10	4

* From *Practical Aspects of Ground Water Modeling* (Walton, 1984).

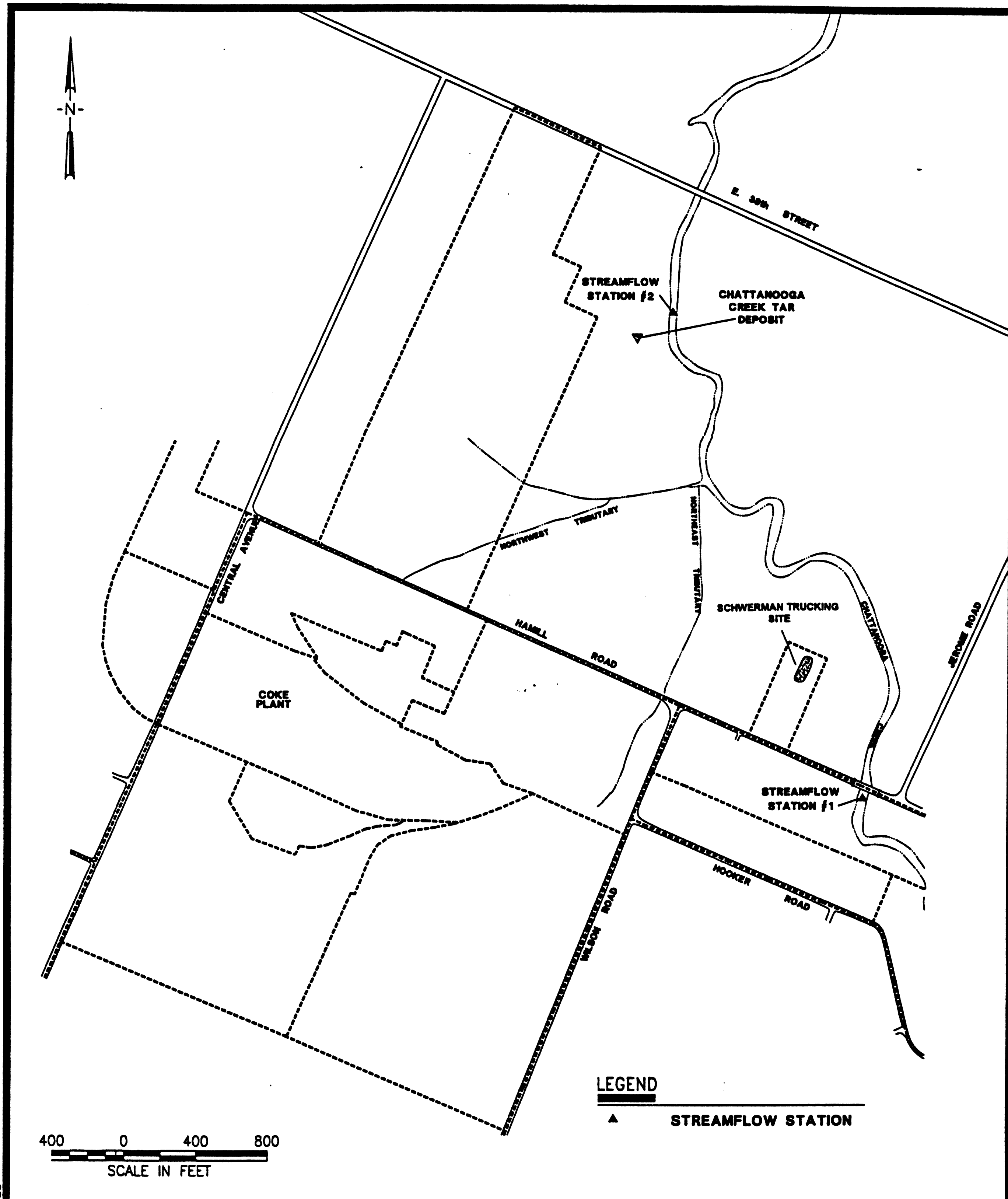
the shallow well than in the intermediate (bedrock) well indicating a downward vertical flow direction, while at 11 monitor well clusters water levels were higher in the intermediate well than in the shallow well indicating a upward vertical flow direction. This apparently random variation in vertical flow direction is again indicative of the tortuous nature of groundwater flow at the site.

2.5 SITE-SPECIFIC HYDROLOGY

In June 1996, baseflow measurements were taken in Chattanooga Creek at the two locations shown in **Figure 2-6**. A type AA current meter was used to measure the stream velocity and a tape measure was used to measure the cross-sectional area. Based on the measurements taken, the following baseflows were calculated:

- Station #1 - 69.6 ft^3/sec
- Station #2 - 73.6 ft^3/sec

Since there was no significant flow discharging from both the Northwest and Northeast Tributaries into Chattanooga Creek at the time these baseflow measurements were taken, the above baseflow measurements indicate that Chattanooga Creek is a "gaining" stream thus further supporting the conclusion that groundwater discharges to this surface water feature.



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STREAMFLOW MEASUREMENT LOCATIONS

CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 2-6